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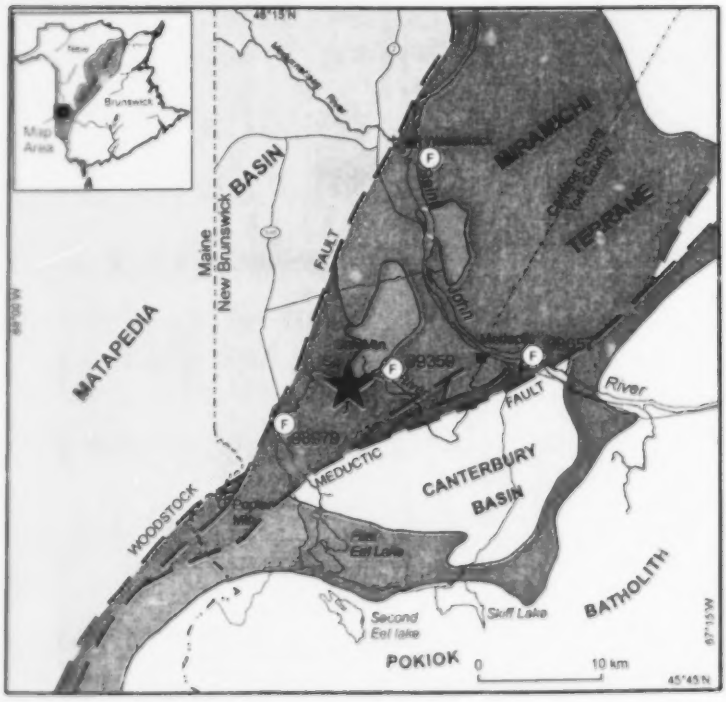
Field Guidebook

A Look at an Ancient Volcanic Environment in the Meductic Area, West-Central New Brunswick

Les Fyffe and Reg Wilson

2003



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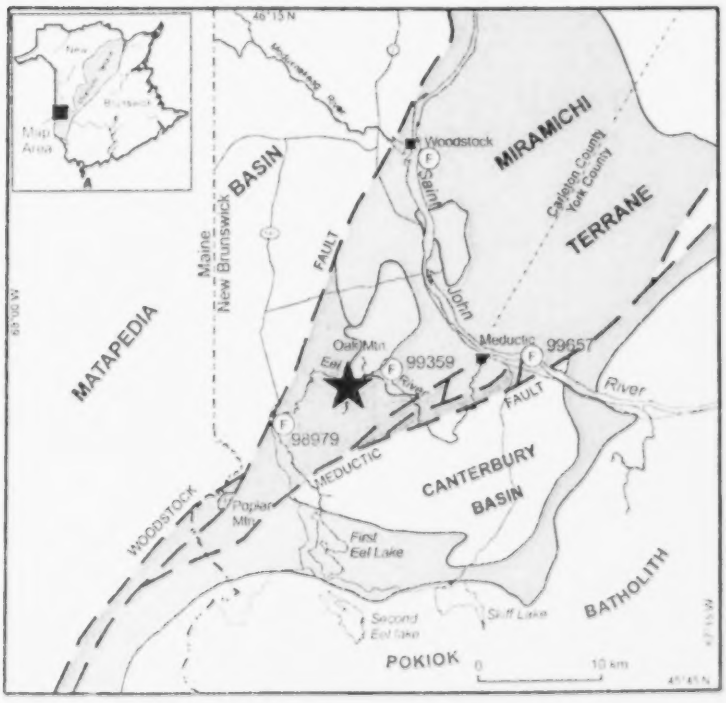

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Minister of Natural Resources

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A Look at an Ancient Volcanic Environment in the Meductic Area, West-Central New Brunswick

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Introduction

This field trip will visit a number of interesting sites within an Early Paleozoic sequence of volcanic and sedimentary rocks in the Meductic area of west-central New Brunswick. A variety of features displayed by these rocks will be examined and used to reconstruct the geological conditions that existed at that distant time in the past. Distinctions between volcanic rock types ranging from basalt to rhyolite (mafic to felsic) will be described in terms of colour, hardness, mineral content, and texture. Their stratigraphic succession (order in which the beds were laid down) and mode of deposition (marine versus subaerial) will be demonstrated using criteria such as graded bedding, pillow structures, presence of fossils, and age determinations obtained from radiometric minerals in the rocks. Together, these many pieces of evidence provide a fairly clear picture of the nature of the volcanic activity that took place in this area of New Brunswick during the early part of the Ordovician period some 485 to 475 million years ago.

Regional Geology

The Meductic area is situated in west-central New Brunswick in the southwestern part of the Miramichi Terrane. The Miramichi Terrane, an uplifted block underlying the axial region of the Province of New Brunswick, is characterized by a thick Cambrian-Early Ordovician sequence of quartz-rich sandstones overlain by Ordovician volcanic rocks. The Miramichi Terrane in the Meductic area is flanked to the southeast by the Canterbury Basin and to the northwest by the Matapedia Basin (Fig. 1). The Canterbury Basin contains shallow-water marine conglomerate, limestone, calcareous sandstone and volcanic rocks of Siluro-Devonian age; its boundary with the Miramichi Terrane is marked by the Meductic Fault but an unconformable relationship is preserved in places. The Matapedia Basin is underlain largely by deep-marine calcareous shale and limestone of Late Ordovician to Late Silurian age; its boundary with the Miramichi Terrane is marked by the Woodstock Fault. Strata within the Miramichi Terrane are generally more complexly folded than those in the adjoining basins.

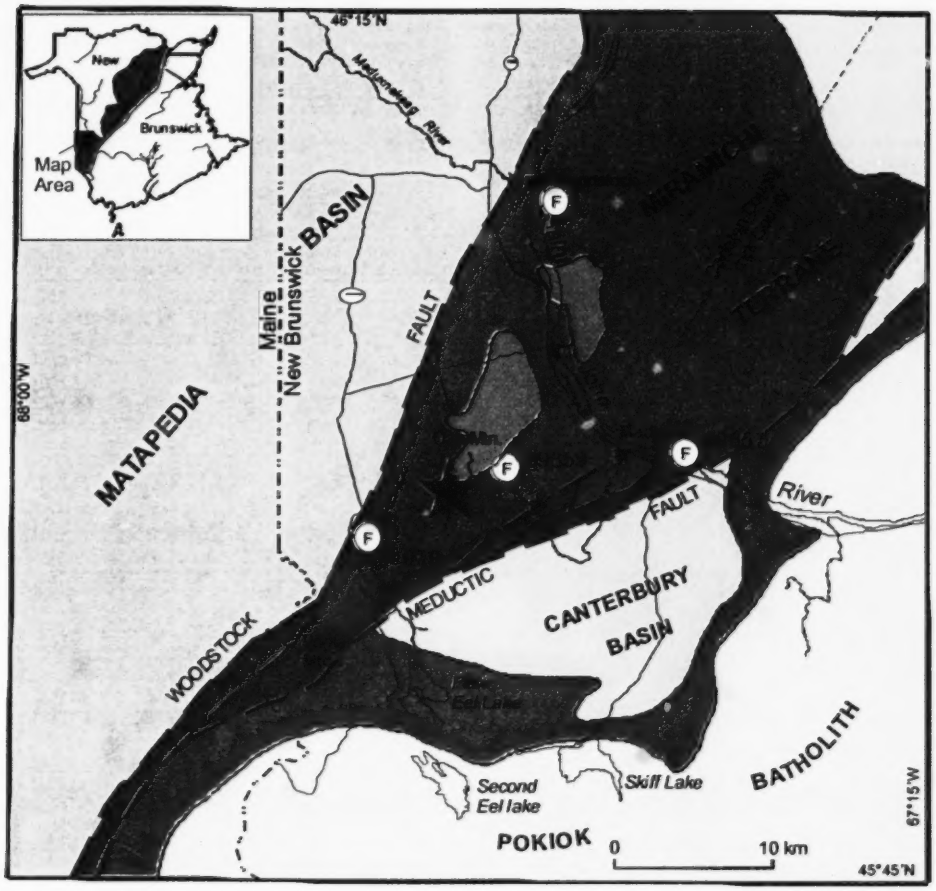

Figure 1. Regional geological map of west-central New Brunswick and adjacent Maine. Blue = Cambrian-Early Ordovician Woodstock Group of Miramichi Terrane; Green = Ordovician Meductic Group of Miramichi Terrane; Red = Ordovician Plutons. Grey = Late Ordovician – Silurian Matapedia Basin; Brown = Siluro-Devonian Canterbury and Tobique basins; Pink = Devonian Granite; Circled F = fossil locality; Star = location of field trip.

Early Ordovician rocks in the Meductic area can be divided into two major groups based on contrasting lithological characteristics. Sedimentary rocks have been referred to as the Woodstock Group and overlying mainly volcanic rocks as the Meductic Group (Fig. 2, 3). The Woodstock Group has been further divided into quartzose sandstone and shale of the Baskahegan Formation and overlying shale of the Bright Eye Brook Formation. The Meductic Group has been divided from its base to top into rhyolitic volcanic rocks of the Porten Road Formation, andesites and bedded volcaniclastic rocks of the Eel River

Formation, basaltic volcanic rocks of the Oak Mountain Formation, and feldspathic sandstone and shale of the Belle Lake Formation. The volcanic rocks include massive porphyritic, aphyric, and pillowed varieties, monomictic and polymictic breccias, and bedded volcaniclastic rocks that are interpreted to have been deposited as submarine lava flows and autobreccias, explosive pyroclastic breccias and tuffs, and as reworked pyroclastic and hyaloclastic tuffs.

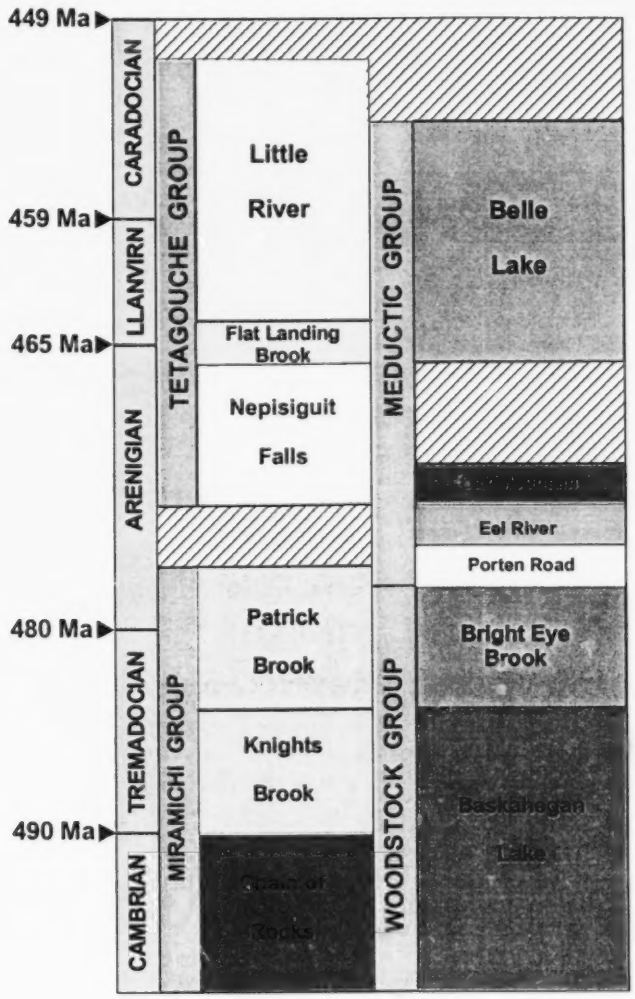

Figure 2. Stratigraphic columns comparing Cambrian-Ordovician rock formations of the Miramichi Terrane in west-central and northern New Brunswick.

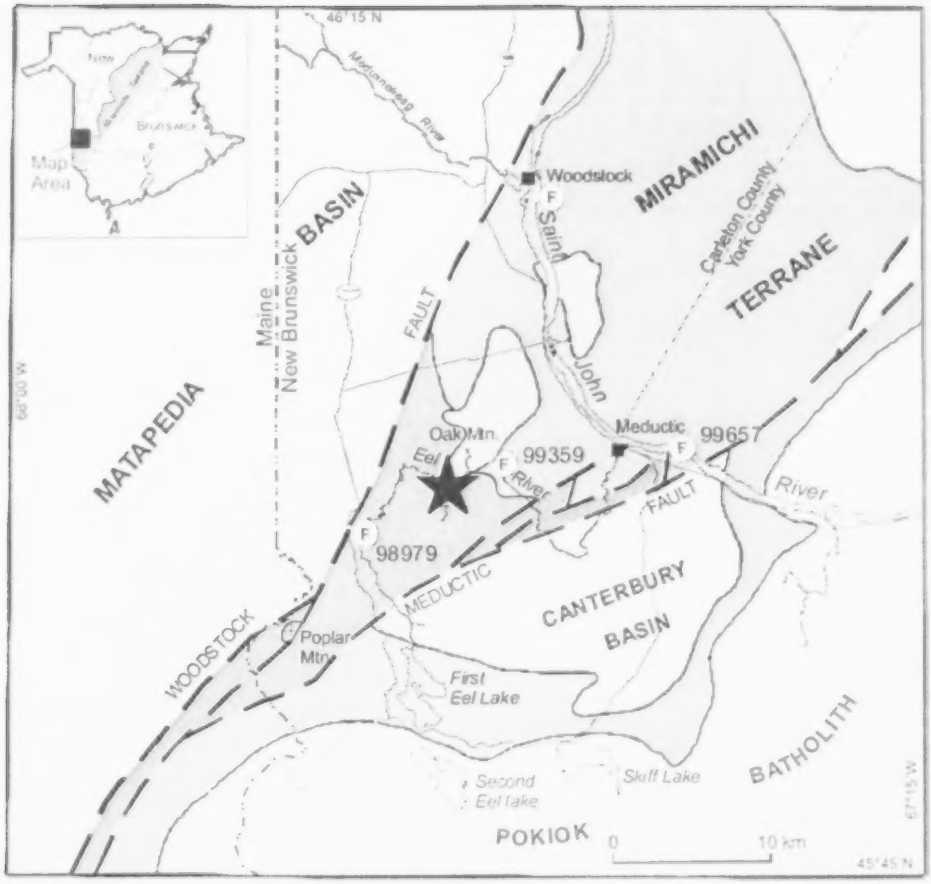

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Figure 2. Stratigraphic columns comparing Cambrian-Ordovician rock formations of the Miramichi Terrane in west-central and northern New Brunswick.

Figure 3. Detailed geological map of the Eel River area around Benton. Woodstock Group: Blue = Baskahegan Lake Formation; Grey = Bright Eye Brook Formation. Meductic Group: Yellow = Porten Road Formation; Orange = Eel River Formation; Green = Oak Mountain Formation; Dark Brown = Belle Lake Formation; Red = Benton Pluton. Light Brown = Siluro-Devonian sedimentary and volcanic rocks. Location of area is outlined on Figure 1.

Figure 3. Detailed geological map of the Eel River area around Benton. Woodstock Group: Blue = Baskahegan Lake Formation; Grey = Bright Eye Brook Formation. Meductic Group: Yellow = Porten Road Formation; Orange = Eel River Formation; Green = Oak Mountain Formation; Dark Brown = Belle Lake Formation. Red = Benton Pluton. Light Brown = Siluro-Devonian sedimentary and volcanic rocks. Location of area is outlined on Figure 1.

Field Stop Descriptions

Proceed 78.0 km north on Trans Canada Highway from Hanwell Road overpass in Fredericton. Turn left onto Benton Road, north of Meductic, and proceed 1.7 km west on Benton Road

Stop One: Exposures on left side of road at beaverdam is light greyish green, medium bedded quartzose sandstone interstratified with thinner beds of darker greyish green, silty shale. These sedimentary rocks are typical of the Baskahegan Formation that underlie the volcanic rocks of the Eel River area.

7.7 km on Benton Road, turn left across covered bridge in Benton. Proceed 3.0 km south on Benton Road.

Stop Two (A): Black shale on west side of road displays steeply dipping laminations (very thin bedding) that are cross-cut by a cleavage trending 30° and dipping 75° NW. (Fig. 4).

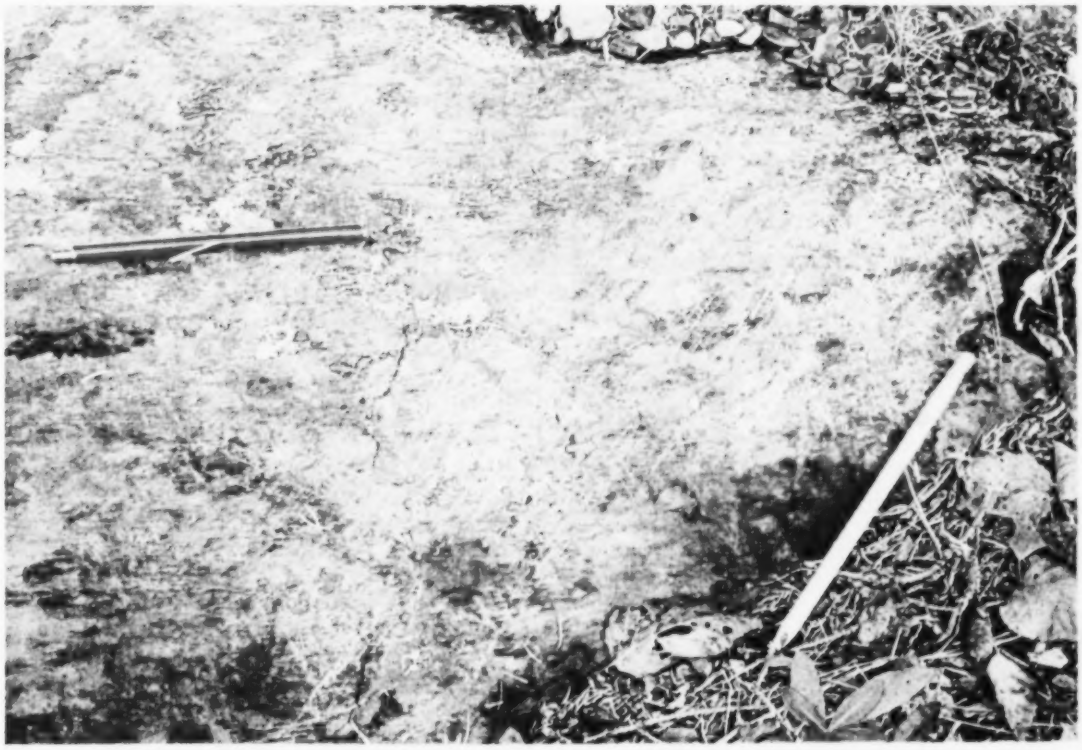

Figure 4: Black shale of Bright Eye Brook Formation with laminations parallel to pencil and cleavage parallel to magnet.

The black shales belong to the Bright Eye Brook Formation from which graptolites of Early Ordovician age have been recovered on Eel River, a short distance downstream from the covered bridge in Benton (Fig. 3). The black shales overlie and are therefore younger than the Baskahegan Formation as indicated by graded bedding in the quartzose sandstone beds of the latter.

Walk about 50 m west on wood road just south of black shale exposure.

Stop Two (B): Exposure on right side of road is a dark greyish green, monomictic volcanic breccia containing feldspar phenocrysts from 1-2 mm in length, and angular fragments of andesitic composition from 2-5 cm in size. Note how some of the fragments appear to fit more-or-less together like pieces of a jig-saw puzzle (Fig. 5).

Figure 5: Angular fragments in autobrecciated andesite at the base of the Porten Road Formation. Fragments represent portions of solidified crust that have been incorporated into fluid parts of the flow.

Jig-saw textures are created as lava erupts into water and are quenched partly to glass and fractured as a result of rapid cooling and flowage of the lava. The fragmentation process is referred to as autobrecciation since it results from movement of the lava itself rather than from explosive release of hot gases prior to deposition, for example.

The andesite breccia presumably marks the base of the Porten Road Formation and likely would have originally been laid down on the black shale beds of the Bright Eye Brook Formation. However, extensive shearing that can be observed along the contact between the breccia and shale suggests that their boundary is a fault at this location.

100 m south on Benton Road.

Stop Three: Light greyish green dacitic to rhyolitic polymictic breccia on the west side of the road contains sparse to abundant quartz phenocrysts about 2 mm in size, plagioclase phenocrysts about 1 mm in length, and fragments of black shale typically from 2-5 cm in size but with some up to a metre in diameter (Fig. 6).

Figure 6: Quartz-rich crystal tuff (below hammer) of Porten Road Formation with incorporated block of black shale (above hammer).

Quartz phenocrysts in the felsic volcanic rocks of this part of the Porten Road Formation are fractured and broken attesting to an explosive origin. The felsic breccias and tuffs, therefore, likely represent pyroclastic deposits that were erupted into a submarine environment. The black shale fragments may have been ripped up from underlying black shale of the Bright Eye Brook Formation as the pyroclastic flows rushed down slope onto the sea floor. Siliceous green siltstone heavily stained with manganese overlies the breccia just to the south and is another indicator of deposition in a marine setting.

400 m south on Benton Road.

Stop Four: On west side of road, greyish pink lithic-crystal tuff contains quartz phenocrysts about 1mm in size, and abundant felsic volcanic fragments ranging from 1-15 cm in diameter (Fig. 7). Sulphide clasts several centimetres in length have been excavated from the outcrop.

Figure 7: Greyish pink lithic-crystal tuff of Porten Road Formation with abundant felsic volcanic and sparse black shale fragments.

Dark grey shale and andesite breccia underlie the lithic-crystal tuff just to the north suggesting a similar stratigraphic position within the Porten Road Formation as at Stop Three.

200 m south on Benton Road.

Stop Five: On west side of road, thick-bedded, coarse-grained, medium greyish green dacitic tuff contains abundant plagioclase phenoclasts from 2-3 mm in length (Fig. 8). About 5 metres to south, a bedded volcaniclastic sequence grades southward from a thin-bedded (3-4 cm), medium greyish green, sandstone into laminated greyish green and grey siltstone beds overlain by 3 cm of dark grey shale. Bedding trends 65° and dips 55° (Fig. 9).

Figure 8: Thick-bedded, greyish green dacitic tuff containing abundant plagioclase phenoclasts.

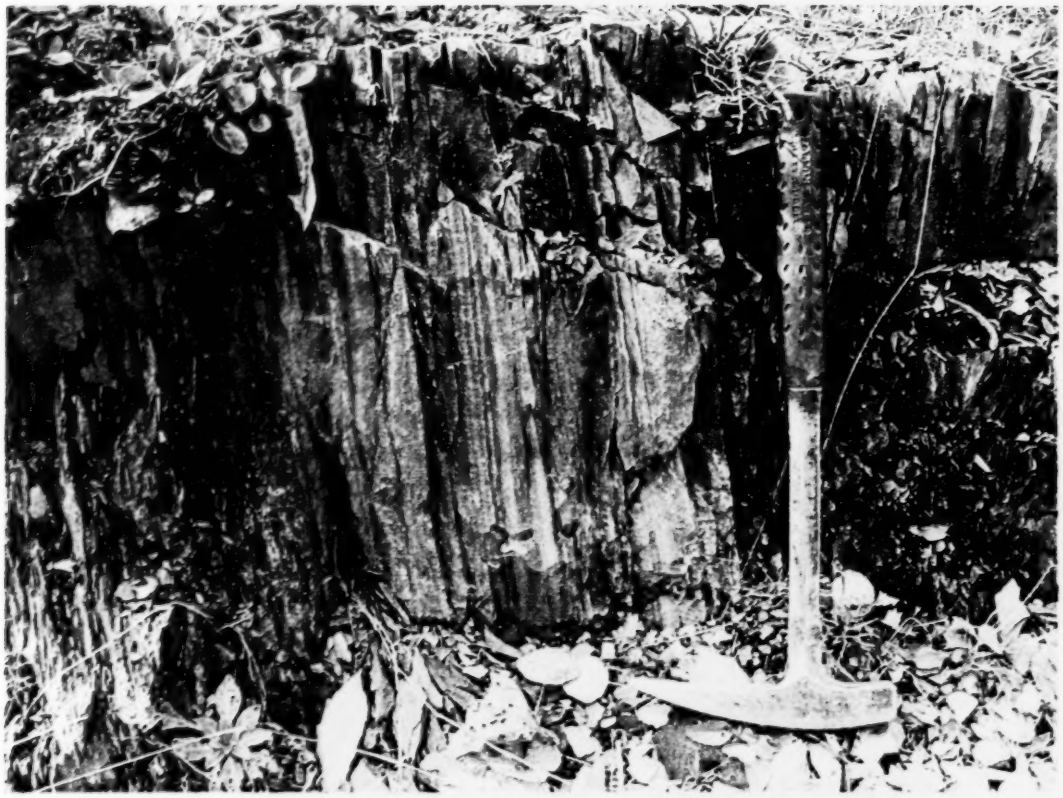

Figure 9: Greyish green volcaniclastic sandstone and laminated greyish green and grey siltstone beds (left of hammer) overlain by dark grey shale. Bedded volcaniclastic rocks are common in the Eel River Formation.

These stratified dacitic tuffs and volcaniclastic rocks characterize the Eel River Formation, and on the basis of graded bedding overlies the more felsic tuffs and breccias of the Porten Road Formation. Felsic fragments within dacitic breccia just to the south of this exposure may have been derived from the underlying Porten Road Formation. (Fig. 10). The bedded nature of the tuffs and associated volcaniclastic rocks suggest that they represent pyroclastic rocks that have been variously reworked and transported deeper down-slope from their original site of deposition in the marine basin.

Figure 10: Felsic fragments (under blue handle and at head of hammer) within dacitic breccia of the Eel River Formation. The fragments were possibly derived from the underlying Porten Road Formation.

200 m south on Benton Road.

Stop Six: On east side of road, dark greyish green basaltic tuff in beds from 0.5 to 1 m thick are interstratified with greyish maroon siltstone beds about 15 cm thick (Fig. 11). Beds trend 55° and dip 75° NW. The basaltic tuff contains fragments of porphyritic and aphyric basalt ranging from 5-10 mm in length. These bedded tuffs were likely derived from re-working and transportation of hyaloclastic material eroded from basaltic lava flows erupted further up-slope in the marine basin. These massive basaltic flows and bedded tuffs belong to the Oak Mountain Formation, which forms the uppermost part of the volcanic sequence in the Meductic area.

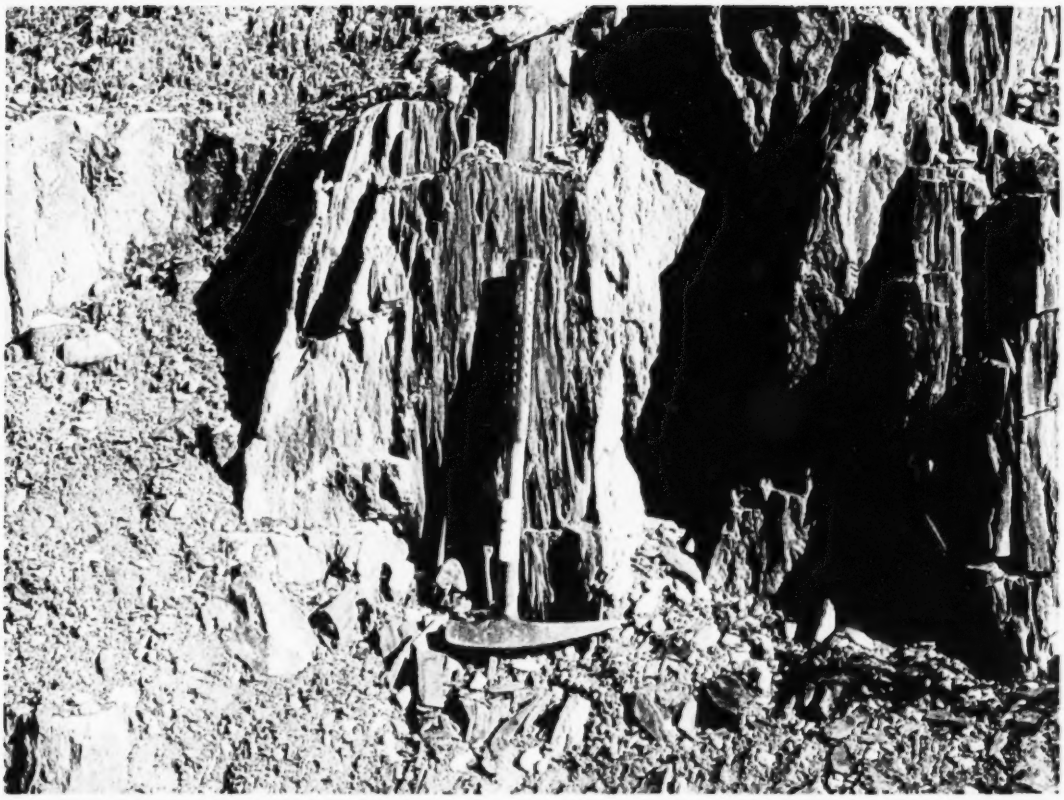

Figure 11: Greyish green basaltic tuff beds (left and right of hammer) of Oak Mountain Formation interstratified with dark grey siltstone (beneath hammer).

Return north on Benton Road to Stop Three *and take wood road to east.*
500 m east on wood road.

Stop Seven: On north side of road, light greyish green, massive quartz-feldspar porphyry of the Porten Road Formation is flooded by 2-3 cm quartz veins. An outcrop in the roadbed comprises pale pink porphyry fragments exhibiting a jig-saw texture (Fig. 12). The presence of this autobrecciation likely resulted from quenching of a viscous felsic lava flow as it was extruded on to the sea floor. Such lava flows would not have travelled far from their eruptive centers compared to the pyroclastic tuffs and breccias of the Porten Road Formation that would have been discharged explosively into the water column.

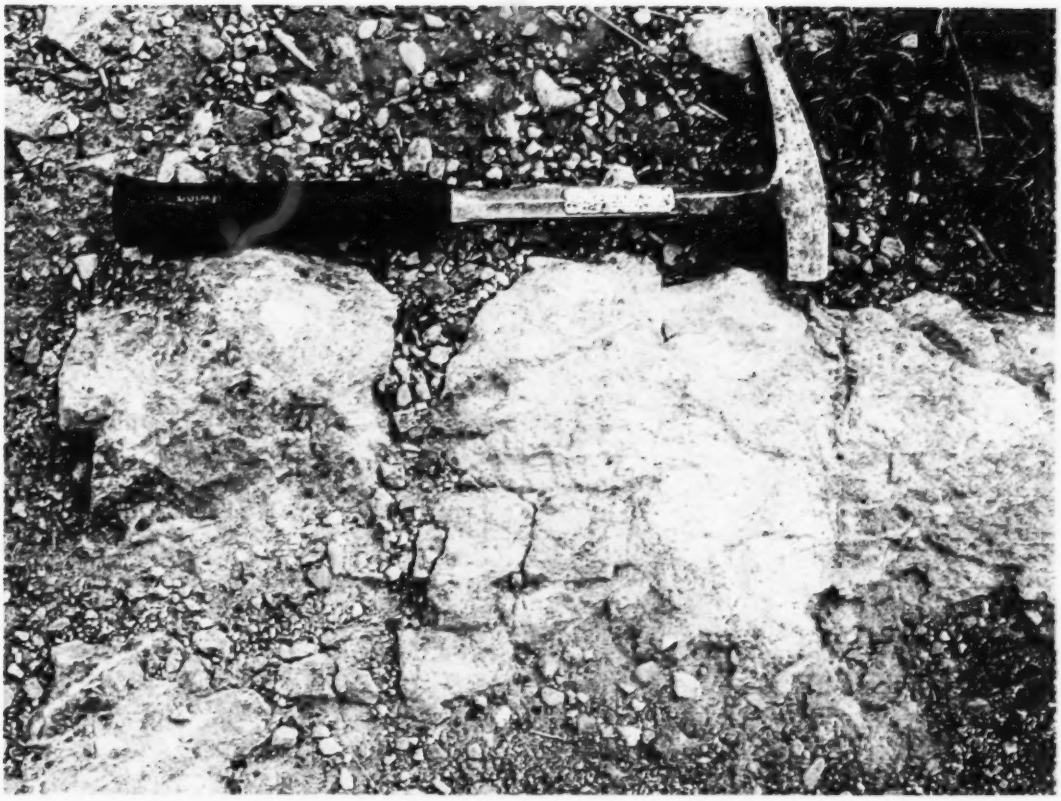

Figure 12: Autobrecciated pale pink quartz-porphyry of the Porten Road Formation likely formed near an eruptive centre.

Return to Benton road and turn north to Stop Two. *Take wood road to west. 700 m west on wood road, take fork to the right and go northwest for 600 m.*

Stop Eight: On right side of wood road, massive coarse-grained, medium greyish green dacitic tuff of the Eel River Formation grades northwestward into a 3 m thick package of thin-bedded (beds 2-3 cm thick) volcaniclastic sandstone (Fig. 13), topped by an interval of greyish maroon siltstone (10 cm thick). The siltstone is overlain by a massive, dark green basaltic lava flow containing conspicuous black phenocrysts of pyroxene (Fig. 14). Pyroxene-phyric basalt flows are common in the Oak Mountain Formation.

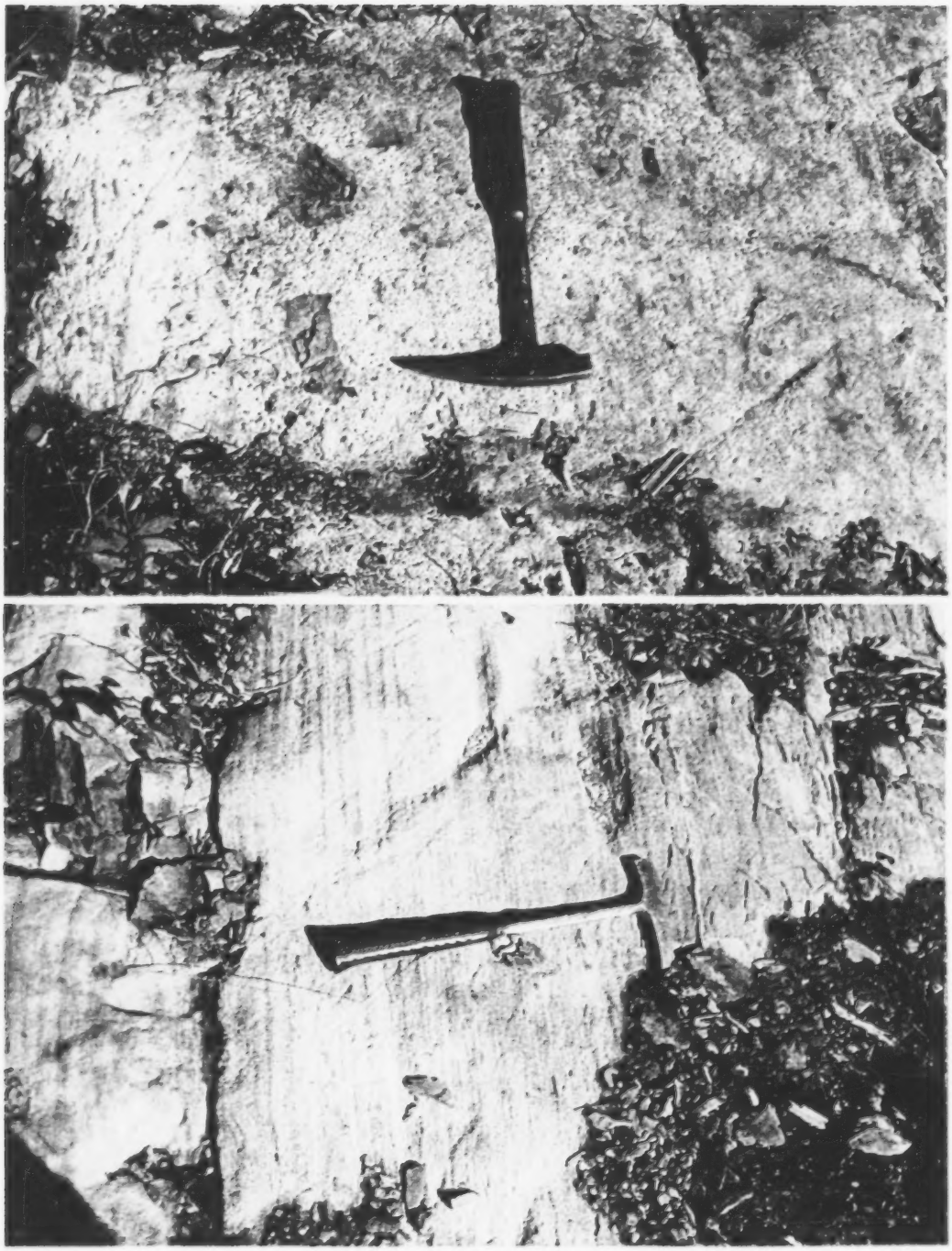

Figure 13. Massive greyish green dacitic tuff of the Eel River Formation containing fragments at its base (top picture), grading upward into thin-bedded volcaniclastic sandstone (bottom picture).

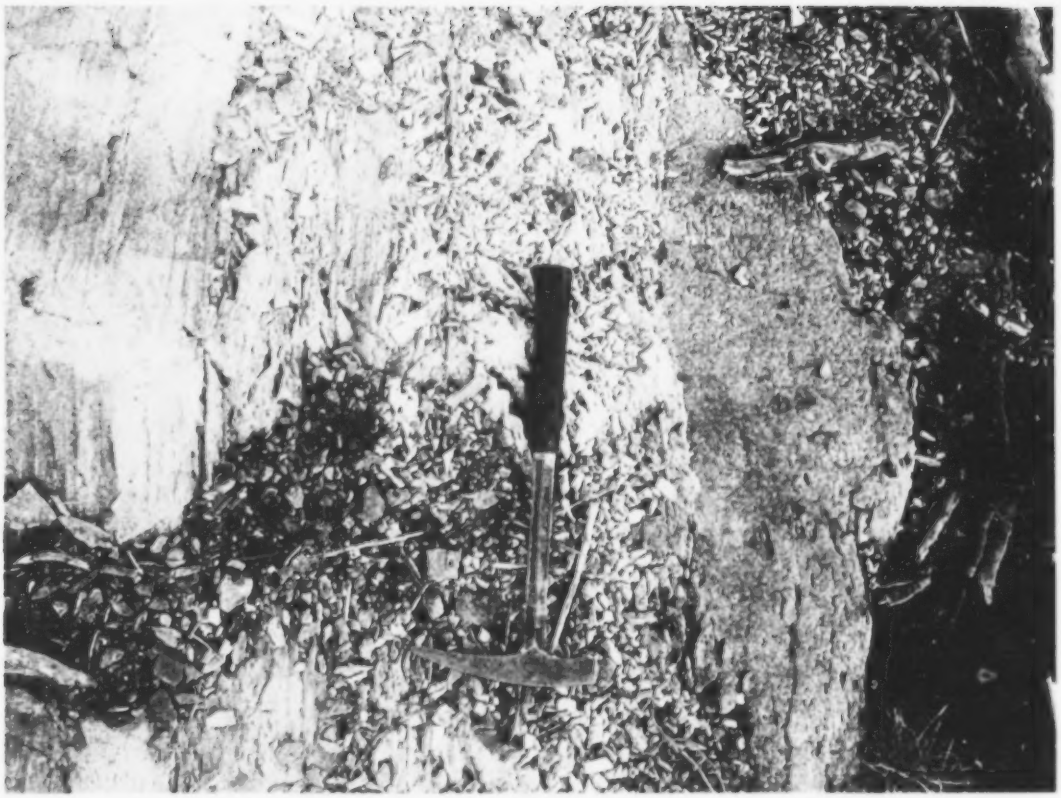

Figure 14: Volcaniclastic sandstone (left of hammer) and greyish maroon siltstone (beneath hammer) of the Eel River Formation overlain by dark green basalt of the Oak Mountain Formation (right of hammer).

Return southeast and turn right onto the fork to the south.
600 m south on wood road prior to beaverdam, proceed about 50 m into clearcut on east side of road.

Stop Nine: Brown-weathering, highly vesicular, pillowed basalt of Oak Mountain Formation is exposed on a knoll Green to maroon chert fill spaces between some of the pillows. Pillow structures are convincing evidence that the lava flows were deposited in a submarine environment (Fig. 15).

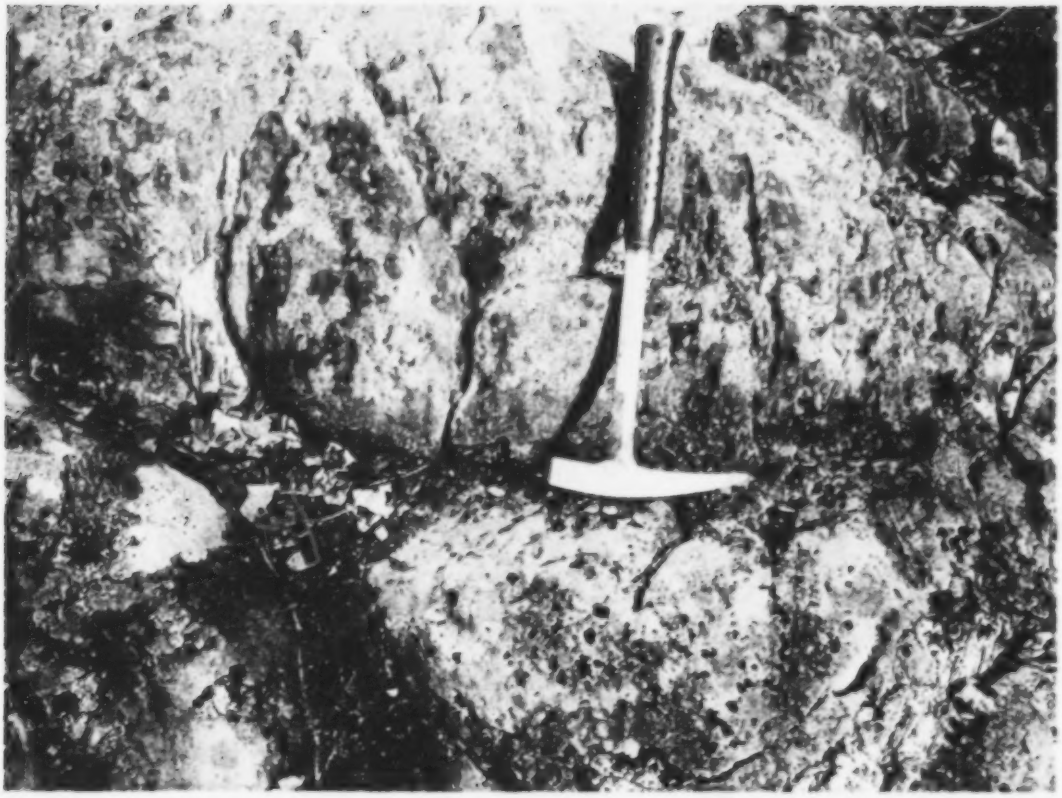

Figure 15: Pillowed basalt of Oak Mountain Formation. Note the large open vesicules in the pillow below the hammer.

Return to Benton, go east on Benton Road and turn left onto Caldwell Road.
1.4 km north on Caldwell Road.

Stop Ten: On east side of road, greyish pink, medium-grained, equigranular, hornblende-bearing granodiorite of the Benton pluton (Fig. 16). Radiometric dating of the similar Gibson pluton located near Woodstock gave an age of 479 ± 7 million years (Early Ordovician). The upper part of the volcanic sequence in the Meductic area is unlikely to be younger than Early Ordovician as the Benton pluton intrudes the basaltic rocks of the Oak Mountain Formation.

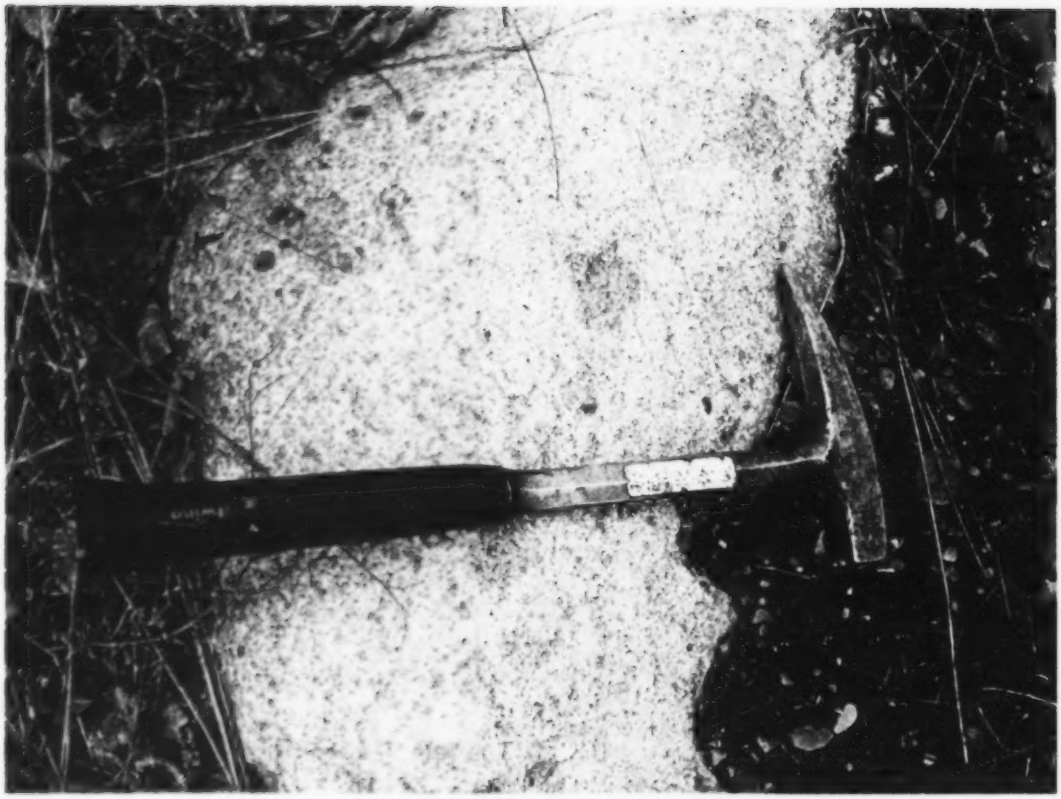

Figure 16: Greyish pink, hornblende-bearing granodiorite of the Benton pluton.